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The Sutro Tunnel.

THE originator of this great work—the great est mining enterprise of ancient or modern times—is Adolph Heinrich Joseph Sutro, who was born at Aix la Chapelle in 1830, and who emigrated to this country in 1849.

After engaging for a time in mercantile pursuits, Mr. Sutro became interested in the mining resources of the country, in which he discovered that the system of surface mining so extensively practised was wasteful in the extreme, both as tending by the exhaustion of surface indications to hide the enormous wealth of deep deposits, and by its crude operations to leave diffused among large accumulations of debris a great quantity of precious metal that might be obtained by more refined and scientific methods.

He visited the great Comstock lode in 1860, and with great sagacity perceived the true relations of that vein with the surface. He concluded that this lode was a true fissure vein, and at once saw the great advantages which must accrue from opening it by a deep tunnel entering at the foot hills on Carson River. We cannot find space to record the enormous difficulties which were met by the projector in bringing this scheme before the public in such manner as to secure the necessary legislation and funds to begin and prosecute his gigantic undertaking. Suffice it to say that he succeeded in securing the aid of capitalists to form a company. Congress was then asked to aid the project by a loan, and in 1866 passed what is known as the Sutro Tunnel Act.

At this stage of the enterprise a powerful opposition, headed by the Bank of California, made strenuous efforts to defeat it. This was a beginning of a long series of attempts by legislative interference to cripple the enterprise, the history of which attempts is not altogether honorable to those who participated in them, and which it demanded the utmost vigilance on the part of those prosecuting the work to successfully overcome. Mr. Sutro, however, has shown abilities which entitle him to rank with Lesseps as an engineer, financier, and an adroit master of legislative tactics. The work was begun in 1869. The description of the tunnel which follows is condensed from the *Polytechnic Review*. The engravings

on the first and fourth pages of this number illustrate features of the near vicinage of the work.

The tunnel commences at the town of Sutro, laid out at the entrance of the tunnel upon land

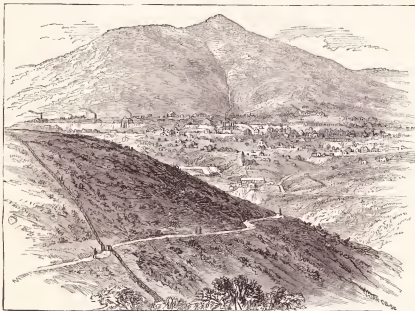
Solferino and Julia⁵ lodes, reaching the Comstock at a horizontal distance of about 20,500 feet from the entrance, and a perpendicular depth of nearly 2000 feet. There are four perpendicular shafts at distances of about 4000 feet apart, the first of which is about 5000 feet from the entrance. There is also an air shaft about 2250 feet from the entrance. Shaft No. 4 is about 1500 feet in depth.

Work upon the tunnel was begun on the 19th of October, 1869; but as only about fifteen men were employed at first, it progressed slowly, not over 460 feet having been made up to January 1st, 1870. During the latter year Mr. Sutro was at times actively superintending the work, and at other times employed in increasing subscriptions to the enterprise, the work accomplished that year being 1200 feet. In the winter of 1870-71, on the petition of Mr. Sutro, Congress authorized the appointment of a commission to make inquiry into the cost and utility of the work, and report upon the same. The President appointed on this commission Major-General H. G. Wright, Major-General J. G. Foster, and Professor W. Newcomb. In the summer of 1871, these commissioners visited and examined the tunnel and the mines of the Comstock lode. Their report, though not so complete as was expected, was yet a valuable document. They found the proposed work to be entirely feasible, estimated the cost at \$4,500,000, and the time necessary to complete it at three or four years—less, if machinery were employed; giving it as their opinion that the Comstock lode was a true fissure vein, extending down into the earth indefinitely.

In the fall of 1871, Mr. Sutro was successful in making such financial arrangements abroad as enabled him to prosecute the work more rapidly than he had before been able to do. The working force was increased, machinery was purchased, and active operations began on a more extensive plan. Four vertical shafts were located along the tunnel line in November of that year.

In the year 1871 the progress made was 915 feet, an average per month of 76½ feet, and the total length of the tunnel at the close of the year was 2165 feet.

(Continued on page 64.)



VIEW OF VIRGINIA CITY AND MT. DAVIDSON FROM SUTRO TUNNEL COMPANY'S ROAD.—Mt. Davidson, 3600 feet above tunnel, and 7827 feet above sea level.



VIEW OF GOLD HILL, THE SOUTHERN PART OF THE COMSTOCK LODGE.

purchased from the United States, in the valley of Carson River, about 3½ miles below Dayton, and 1½ miles from the river. It enters the mountains at an elevation of about 150 feet above the river bed, and has a course nearly W.N.W. The grade of the tunnel is three inches in 100 feet. In its way to the Comstock lode it cuts the Bella Union, Monte Cristo,

thorough and extensive plan. Four vertical shafts were located along the tunnel line in November of that year.

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INVENTORS or manufacturers who desire to secure first-class engravings of machinery or other appliances useful in the industrial arts with a view to use such engravings for the illustration of circulars, etc., may obtain the best work by application to our office. Having secured the services of able and accomplished artists, we are now prepared to execute orders for engravings in the highest style of the art, and fully as cheap as such work can be obtained elsewhere. When such work is ordered of us, and the subject is one of interest to our readers, we will, when desired, publish a description of the same in the SCIENTIFIC NEWS, making no charge for the publication beyond the bare cost of the engraving. In this way a good engraving may be secured and the subject thereof brought into public notice at the simple expense of the engraving.

WE offer an extremely liberal cash commission to all persons who will interest themselves in obtaining subscribers for the SCIENTIFIC NEWS. Particulars will be given and all necessary information furnished on application. Mechanics out of employment, in manufacturing centers where they are known, can in this way profitably employ their enforced leisure.

The Failure of the Act to Amend the Patent Law.

THE country has great reason to congratulate itself upon the failure of this bill in the House. For some reason, probably the earnest and loud protest which was made against its iniquitous provisions, together with the press of business which crowded the close of the session, the bill seemed to lie unheeded, and it seems to be the general opinion that it will not be brought up in the extra session. It is true that an effort to revive it may be made in a future Congress, but all delays are favorable to its ultimate defeat.

Had it passed, as was, gravely feared, it would have struck a blow at American industrial progress, which, coming just at the time when our increasing trade abroad has imparted its courageous hope, would have been most disastrous. The adjournment of the House without further noticing the bill will therefore be hailed with gladness all over the land by every friend of our patent system, which means the welfare of the country at large and foe to every measure that seeks to deprive genius and industry of their due reward.

Can Fires Result from Steam-Heating Apparatus?

THIS question, repeatedly asked and variously answered, now appears to be reopened by facts contained in the article on "Spontaneous Combustion," which we print in another column. A positive answer seems now possible; and the danger appears not wholly confined to apparatus in which high-pressure steam is employed.

The perusal of the article referred to will make plain the fact that in certain states which wood may assume, it may, under favoring circumstances, take fire even at a low temperature by reason of the energy with which it absorbs oxygen. This condition is a semi-chance, excessively porous state, which wood may acquire after prolonged exposure to quite a low temperature in very dry situations.

Some years since, the writer made somewhat extensive investigations into the condition of wood-work in close proximity to steam-pipes. He found that in a great many instances pine wood within from two to five inches from such pipes was very nearly if not quite in the condition described. Its color varied from light brown to almost black, in most cases it could be crumbled with the fingers like charcoal, and its porosity was in all instances greatly enhanced. Differences in the physical character of this semi-charred wood, exposed to the same pipes, were also noted, and were found, which the temperature in the different places could not presumably have much varied, appeared to result from original differences in the constitution of the wood itself. This is the more probable from the well-known fact that wood of the same kind of trees, and even from the same tree, varies greatly in density, not only from natural causes (as, for instance, the difference between what is called the "sap" and the "heart" of the timber) but also from the time in the year of the cutting, method of seasoning, etc.

The semi-charred, porous condition described was not only found in soft kinds of wood exposed to the near heat of pipes carrying high steam, but also in hard wood, and in soft wood near low-pressure steam-pipes. It is our recollection, however, that with low steam-pipes no wood was found so changed in character except when in quite close proximity to or touching the pipes. From what we observed we are inclined to believe that a distance of three or perhaps even two inches from pipes carrying steam not exceeding four or five pounds above atmospheric pressure, would be safe for almost any sort of wood commonly used in the interiors of buildings. We should not, however, deem it safe, in view of the facts and observations set forth in the article to which we have called attention, to place any kind of wood in actual contact with even a pipe never heated above 212° F., and we should have fears of some of the soft and naturally light and porous woods placed an inch from such a pipe.

Of course, if the precise character of natural wood, which in rare instances is capable of assuming, under such circumstances, the condition for the energetic absorption of oxygen necessary to ignition were well understood, the rejection of such wood would insure absolute safety; but as this is not yet ascertained wisdom prompts the keeping within the limit of proximity at which any kind of wood may be so altered.

The number of fires which will ever occur from this cause will be small, but being easily avoidable, there is no excuse for ignoring even a small source of danger. When a destructive conflagration has occurred it is little comfort to find that it originated from a rare combination of conditions, especially if the avoidance of the conditions requires only the exercise of a little prudence and foresight.

Practical Tests of Machinery.

THE amount of data deduced from actual experimenting on machinery in this country, and existing in available form for the inventor and the mechanical engineer, is surprisingly small, when the rapidity with which we invent and the vast number of machines existing among us is remembered. It is all the more remarkable that this paucity of really reliable practical information extends to many of the most important applications of the laws of mechanics.

Despite our great railroad enterprises, we know little or nothing relative to the resistance of trains to the hauling power. Although we are colossal in our engineering interests, the capabilities of our rock-drill are not definitely determined. There are no complete data covering

the vital question of steam expansion under all conditions. The laws of friction are virtually unsettled, and in a semi-chaotic state. Our knowledge relative to the nature and efficiency of lubricants is, at best, vague. Our great moneyed institutions constantly fall a prey to thefts, and yet no two safe manufacturers can agree as to the best mode of burglar-proof safe construction; and not one of them knows that his safe is absolutely secure. We have only just found out that the tests we have been applying to chain-cables have yielded untrue records and proved a source of injury to the chain; and we are really only on the threshold in point of sound knowledge of the laws of health and disease as applied to the structures we live in. Plenty more such examples might be enumerated, all showing the need that exists for practical tests and definite deductions relative to many classes of mechanical subjects, which tests may be used as standards. Failing these, empiricism in practice and uncertainty in results is the easily foreseen consequence.

We are ready to commend, therefore, the action of several well-known manufacturers who have recently made arrangements to submit their productions to an extended series of tests with a view to securing more accurate and reliable results both for the information of the public and for their own benefit. The immediate motive of these trials, which are now in progress under the supervision of Park Benjamin's Scientific Expert Office, of this city, is to gather data for publication in "Appletons' Cyclopedia of Practical Mechanics," which Mr. Benjamin is the editor. It appears assured, however, that the trials will be continued after the completion of that work. We are informed that the tests already projected include trials of drilling-apparatus, rock-drill engines, and carrying material, ice-machinery, and testing apparatus; and that others, the details of which are not yet settled, are being arranged. These trials are to be conducted wholly under Mr. Benjamin's directions by several well-known engineering experts; and are not controlled by the parties submitting their products, although the tests are carefully devised in consultation with the manufacturers interested.

The rock-drill experiments already begun will exhibit the action of the drills in representative rocks, the distribution of pressure in the cylinder, the power developed, the strokes corresponding to given pressures, quantity of air or steam used, and so on through a large number of important questions. One of the best known high-speed engines is to be the subject of accurate determinations for power used, etc. Carriage-axes and other material used in the wagon industry will be tested for strength and endurance. By the aid of a powerful air-compressor of improved design, the question of the economical production and utilization of compressed air will be fully investigated.

Manufacturers desiring to participate in these tests should consult the announcement regarding them in our advertising columns.

Spontaneous Combustion—Some Remarkable Cases and their Explanation.

M. COSCON recently called the attention of the French Academy of Sciences to a singular accident that had occurred a short time previously in his laboratory. Eight days ago, said he, when I was just preparing to set out for the Academy, my laboratory became the scene of a sudden outbreak of fire. The board flooring in the neighborhood of a stove spontaneously ignited. In consequence of a similar accident two years ago, I had caused the boarding in the vicinity of the stove to be replaced by a marble slab. Notwithstanding this precaution the fire broke out in the wood around the marble. The heat to which the wood was exposed at the points where it ignited was not very great; the air had only a temperature of 25 degrees. But without doubt there had been a slow carbonization of the wood and a rapid absorption of the oxygen of the air, and in consequence a production of caloric sufficient to cause the combustion. Herein lies a danger which should be impressed on the minds of architects and builders. In the case of the fire at the Academy, the application of water, continued M. Coscon, because it was in full daylight and I had seen its commencement; but had it been in the night time, it is clear the fire would have accumulated, without let or hindrance, its work of destruction.

This reminded M. Faye of a case of spon-

taneous combustion that had recently occurred at the house of a friend of his at Passy. The fire was due to the continuous action of the heat of a stove on the surrounding wood-work.

M. Dumas adduced several analogous examples, all of which he explained by that property of finely divided bodies whereby they absorb air very energetically and generate heat. In powder factories, for instance, the pulverized carbon very often ignites of itself. It is for this reason that the practice has been generally adopted of pulverizing it in conjunction with sulphur, because sulphur deprives it of the property mentioned.

In such instances as those cited, the wood deprived of its moisture by long exposure to heat becomes transformed into a substance analogous to lignite or peat. In fact, it is changed into a condition that may be compared to that of powdered wood. In this state it condenses the air and takes fire. It was thus that, on one occasion in his experience, a beam in a coach-house exposed to hot air took fire spontaneously. Sometimes in theatres the lampman's box, filled with miscellaneous oily rubbish, becomes spontaneously ignited. The greasy odds and ends contained therein condense the oxygen of the air. In manufactories where Adriane red is applied on cotton impregnated with greasy material, spontaneous combustion takes place very often.

M. Dumas cites one more singular fact of which he was a witness in the studio of a painter. The artist had taken a piece of cotton to brush and clean his canvas. He gave the oily surface a good rubbing and put the cotton aside. Very soon the cotton ignited spontaneously.

The all-sufficient explanation of these and like cases is the fact that a minutely divided and air-conducting substance has the capability of producing suddenly a high temperature.

American versus English Hardware—Pittsburg Window Blinds Smeared with Paris Green—A Manufacturer's Plea, "They All Do It"—Bisulphide of Carbon—"The Accuracy of the 'Scientific News' Questioned."

At the meeting of the N. Y. Academy of the Useful Arts, on Feb. 26, the relative merits of English and American hardware were discussed.

Dr. Wetherbee had noted recently by a prominent hardware merchant that whereas but a few years ago hardly any other than English hardware was selling here, American manufactured goods in that line had now not only superseded the English in this country, but were even supplanting the latter in old England herself, and were in superior demand in many of the British colonies. Dr. Wetherbee's informant had recently been shipping American-made tools and other hardware goods extensively to Australia, where they were preferred to the English make, both for cheapness and quality.

A gentleman thought the explanation of this state of things was to be found in the well-known English prejudice against all sorts of innovation. He instanced the case of an American workman of his acquaintance who worked for some time in an iron foundry in England. The English masters had their moulds studded with the floor, but the American sunk his moulds in the ground. They laughed at him, but he did twice as much work as any one of themselves, and with far greater facility. Nevertheless, they could never be induced to sink their moulds instead of placing them standing. Again, when another American went over to England with an improved turbine wheel, the innovation met with no favor. When he proved by actual experiment that the adoption of the new wheel would make a saving of 75 per cent, (?) then only could any one be found to listen to him, though the superiority of the American turbine was so manifest that it might have easily been seen at once. That was the kind of argument John Bull required before he could see any merit in a new idea.

Mr. McDonald, on the contrary, thought the prejudice was the other way. He knew an English ship carpenter, who, coming over here to work, and seeing the manifest superiority of the American adze, very promptly discarded the comparatively clumsy English tool.

Dr. Newberry believed that English workmen's aversion to novelty sprang from the keenness of competition there between capital and labor. Whenever the manufacturer introduced any new machine or process, the fears and jeal-

ousy of the workmen were aroused immediately; they thought it was a new move by capital in the warfare against labor. Trades-unions, he asserted, were very detrimental to the working classes. Trades-unions are opposed to all improvements. The radical evil in all nations was the giving of grants to monopolists, instead of giving employment to all useful laborers. In point of fact, if workmen could only see it, competition is exceedingly beneficial. It reduces everything at first to its lowest price, and finally prices adjust themselves so as to be equitable; it enriches everybody if freed from monopolists. But when monopolists invade the field, laborers become and have the right to become jealous. The non-producing classes ought to have no rights in this matter, because they produce nothing and only do their best to crush the working classes out of existence. As regards the present cheapness of labor and the danger to health attending certain employments, the speaker had been in a factory a short time ago where he saw articles made for 5 cents that he used to pay \$2 for making. He had lectured in East Liverpool on the dangerous nature of the pottery manufacture carried on there. A constituent of the crude glaze was red lead, a very poisonous substance, yet not the least care seemed to be taken to guard against it. It was smeared around everywhere, on the walls and on the heads and faces of the workpeople. In about two years' time these people became so badly poisoned that they were good for nothing, and the parish had to support them. To remedy this disastrous state of things, the proprietor told him, would entail a little expense; it would make the price of a cup and saucer about one-eighth of a cent more, and therefore could not be done, unless by general accord among the manufacturers. In Pittsburg he had seen window-shades that were mere rags with paris green daubed over them by hand. He went to the factory and asked the proprietor: "Do you manufacture these?" "Yes," was the answer. "Don't you know that that stuff is poison?" "Yes, but these people (the workers) are only a parcel of Dutchmen, and when one of them gets poisoned we employ another in his place." "But don't you think that's wrong?" The reply was, "They all do it."

Dr. Parmelee explained the uses and manufacture of bisulphide of carbon. One of its best known and most efficient applications was in the manufacture of rubber. One periodical had stated that its manipulation was very unhealthy, while the *SCIENTIFIC NEWS* had recently contradicted this by stating that it was not used in the manufacture of rubber at all. Both these authorities were wrong almost wholly.

Bisulphide of carbon is used not only in the manufacture of rubber, but is very extensively for vulcanizing rubber, both in Europe and America. It is also largely used in Europe for extracting aromatic oil from flowers and vegetables. There are large concerns there for that purpose, and their products are enormous, but the industry has not taken much hold here.

The doctor then explained the nature and chief properties of bisulphide of carbon, and described an improved process for its manufacture which he has patented, and which is now in operation at the Haley Iron Works, between North Fourth and Fifth streets, Williamsburg, N. Y.

The U. S. Testing Machine.

THE following description of the U. S. Testing Machine at Watertown Arsenal, is taken from a paper on the subject read by A. L. Holley, Esq., at the recent Baltimore meeting of Institute of Mining Engineers. This 400-ton testing machine was built by the U. S. Government, and is pointed to test "iron, steel, and other metals," has recently been finished, tested, and accepted.

Among the tests were the following: A forged link of hard wrought iron, 5 in. in diameter between the eyes, was slowly strained in tension, and broke short off with a load report at 222,800 lbs. The diameter before breaking, at the point of fracture, was 5.04 in.; after breaking, 4.98 in. To see if the weighing parts of the machine had been disturbed by the great recoil, a horse-hair was next tested. It was 1/1000 of an inch

in diameter; it stretched 30 per cent, and broke at one pound. Other horse-hairs tested between one and two pounds. The accuracy of these small tests, and others up to some hundreds of pounds, was checked and proved by other weighing machines. Specimens were subjected to a million pounds' compression; and after these, delicate structures, such as eggs and nuts, were tested in compression, and violin-strings in tension. Details of the construction of this remarkable machine cannot now be given, since the inventor, Mr. A. H. Emery, is securing foreign patents. It consists of a double-acting straining cylinder and ram on a carriage, at one end, and a movable weighing apparatus at the other, the two being connected by a pair of 8-inch screws, 48 ft. long. The weighing apparatus is a reversed hydrostatic press, having diaphragms instead of pistons. The load is transferred by means of a fluid (alcohol and glycerine) and successive series of large and small diaphragms to a system of scale-beams. Thus, 800,000 lbs., acting through an inconceivably small space, finally move a graduated indicator 1/100 of an inch per pound. One pound in moving the indicator 1/100 of an inch, moves the platform against which the load presses 1-42,000,000 part of an inch. The machine was built at the Ames Works, Chicopee, Mass. The principal castings (50,000 lbs. of gun-iron) were made at the South Boston Iron Works, and the steel and iron forgings at the Nashua Works. The total weight of finished metal is 175,000 lbs., the pieces ranging from 14,000 lbs. down to 1-250,000 of one pound. The hydrostatic weighing platform of the machine was tested to 1,500,000 lbs.; but so frictionless is it that a 40-horse-hair, under a breaking strain of one pound, had to move 24,000 lbs. of metal. The workmanship throughout is remarkable. For instance, the 8-in. screws, 48 ft. long, were fitted to gauges within 1/1000 of an inch in diameter through their entire length. The cost, to the government, of the machine, including erection, foundations, and auxiliaries, was \$43,004.52. The cost to Mr. Emery was about \$100,000. The importance of a powerful testing machine is very great. Constructors have been led astray by predicting the physical qualities of large bars on those of small ones. This machine, for instance, broke at 700,000 lbs., or about 36,000 lbs. per sq. in., a link sent as "60,000-lb. iron." Iron which, in an inch bar, stood over 50,000 lbs. per sq. in., broke at about 37,000,000 lbs. per sq. in. in a 5-in. bar, turned down to 3 1/2 in. But a large machine is equally important to determine the weakness of structures, and thus lead to the development of perfect forms. The strength of a latticed column, for instance, cannot be calculated from that of the bars of which it is composed. The usefulness of a machine that will take in a whole bridge-post or a whole section of top-chord.

EDISON'S ELECTRIC LIGHT.—After an elaborate technical specification of his invention and of all its details, Mr. Edison sums up his claims in making application for a French patent to protect his electric light inventions in France as follows:

"I claim as my invention—first, the combination with an electric light of a thermal circuit-regulator to lessen direct electric action on the light when the maximum intensity has been attained, substantially as set forth; secondly, the combination with the electric light of a circuit-closing lever, operated by heat from the electric current or from the light, and a shunt or short circuit, whereby the current or a portion thereof from the light, substantially as set forth; third, the combination with the electric light and a resistance of a circuit-closer operated by heat, and serving to place more or less resistance in the circuit of the electric light, substantially as set forth; fourth, the combination with an electric light of a diaphragm operated by the expansion of a gas or fluid in proportion to the temperature of the light to regulate the electric current, substantially as set forth; fifth, the combination with a vibrating body similar to a tuning-fork, of a mechanism for maintaining the vibration, and magnets, cores, and helices, whereby a secondary current is set up so as to convert mechanical motion into electric force, or the reverse, substantially as set forth; sixth, the combination with electric lights, substantially as described, of a means for regulating the electric current to the same in proportion to the heat evolved in the light so as to prevent injury to the apparatus, substantially as set forth."

* The *SCIENTIFIC NEWS* still believes the assertion that bisulphide of carbon is not employed in the manufacture of rubber to be correct. We now repeat the statement, fortified by the authority of an extensive manufacturer of vulcanized rubber who asserts that he knows of no one in England who uses bisulphide of carbon in the way in which it is so used to any extent; and also on the authority of one of the widest known and most celebrated chemical experts in this country, Professor Chandler, of Columbia College.

(Continued from page 61.)

In 1872, the advance was from 2665 to 3450 feet, a total of 815 feet, and an average monthly progress of 67½ feet.

In 1873, the tunnel advanced to 5399 feet, a total of 1910 feet. This includes the 655 feet which had been made in the east and west drifts from Shaft No. 1, connection with which was made by the tunnel header October 27th of this year. Exclusive of these 655 feet, there was an average monthly progress of 105 ¼ feet.

In 1874, the progress began to improve, owing to the introduction of the Burleigh drill. One of these drills was started April 25th; on June 2nd, three additional drills were put in, and on August 7th, two more—making six in all. These drills were run by compressed air, supplied by a powerful compressor located at Shaft No. 1. This compressor was manufactured by the Société John Cockrill, of Seraing, Belgium, and was purchased there by Mr. Sutro, who preferred the heavier European machinery to the American, which is smaller and lighter and consequently more liable to repairs and breakage than the other. This compressor ran with great smoothness and regularity, and with scarcely a single stoppage for repairs. The progress made during this year was 2650 feet, or an average per month of 223 ⅓ feet, bringing the header to a point 8079 feet from the mouth.

pressor at Shaft No. 1 was closed down, and the power has been ever since that date supplied from a very powerful compressor built at Kalk, near Deutz, on the Rhine, by the Humboldt Machine Company, and located at Shaft No. 2. This compressor is a powerful double compressor, and has given great satisfaction.

In the year 1876, the tunnel advanced from 11,807 to 15,477 feet, a total progress of 3670 feet, and an average per month of 305 ⅓ feet.

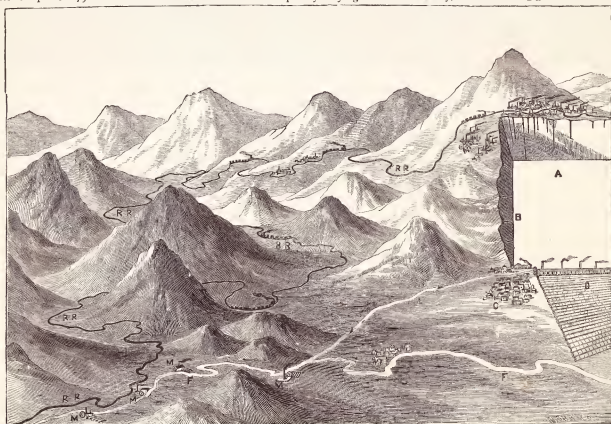
At the close of 1877, the total distance made was 15,607 feet, the progress for the year 3130 feet, and the average per month 260 ⅓ feet. This decline in the rate of progress was due to the exceedingly difficult character of the ground encountered. Soft, slippery and swelling, it was not only exceedingly difficult to pass through, but was also dangerous to work. In many places the clay, after being cut through and exposed to the air, swelled so as to displace the railroad track and to break the stoutest timbers like reeds. The most constant watchfulness was required to prevent accidents. Timbers were replaced again and again, and a gang of men kept continually at work casing up the clay behind them, and driving in lagging to give them additional strength. The tunnel was timbered up to the face itself, and frequently lagging was driven ahead of the drift to prevent accidents. Consequently very light blasts had

in a very satisfactory manner. It is stated that the thermometer on the 2000-foot level of the Savage mine, which had previously stood at 120°, now rises to only 90°. Thus the first benefit from the tunnel project is already realized, though as yet only just begun. An immediate result of the improvement in the air of the tunnel header was seen in the increased progress which was made immediately subsequent to the connection.

The last of the illustrations accompanying this article is a birdseye view of the line of the Truckee R. R., marked RR, which leads from Virginia City to Carson City. The Carson River is indicated at F. A section of the mountains is removed to expose the northern portion of the Comstock lode, marked A. The line of the Sutro Tunnel is indicated at B, and mills at Sutro are marked D. Ore is now hoisted to the surface at Virginia City and transported to mills, M, on the Carson River. After the completion of the tunnel the ore can be delivered at the mills D, at the town of Sutro to one-fourth the present cost of hoisting it.

Gigantic Machinery.

This machinery about to be put up at the North Consolidated Virginia mine, at Virginia City, consists of two gigantic horizontal engines,



BIRD-EYE VIEW OF SUTRO TUNNEL VICINITY.

The greatest progress ever made in a single month was made in December of this year—the extraordinary run of 417 feet, nearly 13 feet a day.

During the year 1875, the average progress per month was 310 ⅓ feet, the total distance run 3728 feet, and the total length of tunnel at the end of the year was 11,807 feet. One of the most interesting incidents of the year, and one not unaccompanied by danger, was the tapping of the enormous body of water which burst into the west drift from Shaft No. 2. This water filled a chamber 341 feet long, 8 feet by 12 in dimensions, besides filling a shaft 5 feet by 10, and over 1000 feet high. On the 9th of March a hole 100 feet long was bored by diamond drill from the face of the tunnel header to allow the water to discharge. Upon tapping the body of water the stream burst forth with tremendous force. Fragments of timber, rock, and debris were soon forced into it, and the hole had to be bored again. Again the water burst out with such force as to shoot the steel drill out into the tunnel; but gradually the water lowered in the shaft, and in a week's time progress was resumed in the header. Some instances of extraordinary progress occurred during this year; as, for example, the run from July 22d to August 8th, 279 feet—about 16½ feet per day for 17 days consecutively.

On the 13th of August of this year the com-

to be used; sometimes even no powder could be fired, for fear of knocking down the timbers. Considering the character of the ground encountered, the average progress must be considered remarkably good. Two drills were also taken off in April, and the work was continued with only four drills for the rest of the year.

1878.—The progress during the present year has been of a lower average still than that of last year, or 235 ⅓ feet per month to September 1st, with the same difficulties to encounter as those of the previous year, and the additional inconveniences of heat and bad air, which became very oppressive. Up to the present writing (September 1st) the total length of the tunnel is 20,480 feet, which brings it very close to the west wall of the Comstock lode, the synonyme of Mount Davidson, and at this point work on the main tunnel has been discontinued.

On the 8th of July, about half-past 10 at night, a connection was made with the east drift, on the 1640-foot level of the Savage mine, at a point 20,015 feet from the mouth of the tunnel. The draught of air was immediate, rushing in from the tunnel mouth and upward through the Savage shaft with great force. Since the exhaustion of the great body of heated and poisoned air which had been pent up in the tunnel and in the lower drifts of the Savage mine for so many years, the air has cooled, and has ventilated and purified these underground workings

coupled together by one crank-shaft. It embraces the entire outfit necessary for hoisting and lowering materials from a deep shaft. The foundation for this machinery will be 25 feet deep, solid and massive. It will be filled up to the top under the engine frame, and spaces will be left under where the levers play. Coping stones will be placed under the engine frames, to raise them above the rest of the structure. The engines will be set 65 feet from the centre of the mouth of the shaft. They will cover an area of 40 by 60 feet.

The two engines, as before stated, are coupled together by one crank shaft—an enormous piece of wrought iron, twenty inches in diameter. Each of the engines is supplied with a cylinder twenty-eight inches in diameter. These cylinders provide for a piston-stroke of ninety-six inches. The piston has been carefully fitted to the cylinder, and arranged for a piston speed of 1000 feet per minute. The piston-rod is six inches in diameter. The outside of the piston is connected to a crosshead three feet in diameter. These massive crossheads which are made of a combination of parts of cast and wrought iron, cast steel and brass, work in circular guides. These guides correspond with the diameter of the crossheads. The rods connecting the crossheads with the crank-shafts are 22 feet in length and 10 inches in diameter. The cranks are of

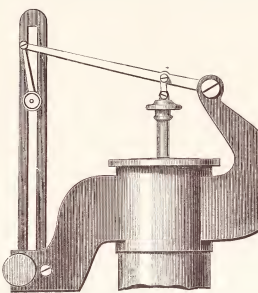
wrought iron, and carry each one a heavy crank-plate cast in two pieces and bolted over. These crank-plates, or fly-wheels, are 13 feet in diameter, and are balanced to offset the weight of the crank. The cranks are keyed on to the extreme ends of the crank-shaft, and are set at right angles. The crank shaft is supported in the centre by an independent pillow-block, and at the ends by pillows connected with the frames of the engines. On the crank-shaft there are two reels attached to the brake-wheels. These reels are six feet in diameter. The rope to be used is a flat one, which is of the description now in general use on the Comstock, as it winds on itself. There is, consequently, no friction of the rope on itself, as in the case of a round rope wound upon a drum. The miners of California and Nevada have discarded the use of the round rope altogether in their hoisting works, on the grounds of superior usefulness and greater economy in the use of flat ropes. The cumbersome drum and the round rope chafing on its own coil are still retained in the deep mines of England and the Continent of Europe. That of the North Consolidated Virginia mine's hoisting works will be five inches across. The reels on which this rope winds are arranged so that the rope used may be six or seven inch if necessary. The brake-wheels are 15 feet in diameter, and have a 12-inch face. The reels with the brake-wheels revolve independently of the crank-shaft, and are brought into action by clutches five feet in diameter, fitted on the octagonal part of the shaft, and consequently rotating with it. These clutches are moved by hydraulic power, under easy control of the brakeman and engineer. Brake-wheels are fitted with heavy traction brakes of wrought iron frames with wooden shoes. These brakes are to be worked exclusively by a brakeman. Strap-brakes are placed upon the crank-plates or fly-wheels, and are controlled exclusively by the engineer. The engine frame is of the Corliss pattern, and is to be firmly bolted to its foundations with bolts $\frac{3}{4}$ inches in diameter and 24 feet long. For convenience in shipping, the frames that connect the pillows and cylinders are cast in two pieces and bolted together in the centre. The engine is supplied with a pair of Behr indicators, through the aid of one of which the engineer can tell the exact position of the cage as it ascends, and the brakeman, through the aid of the other, can tell with the same correctness the position of the cage descending the shaft. The weight of the descending cage is also utilized in this machinery for hoisting the one ascending. Following are the weights of some of the principal parts of the machinery: Cylinders, each 15 tons; beams, each 40 tons; pillow-blocks, each $\frac{7}{8}$ tons; brake-wheels, each 18 tons; crank-plates, each 18 tons; clutches, each 8 tons; connecting-rods, each one-half ton. The total weight of the machinery is 400 tons.

A NOVELTY IN ILLUMINATED DIALS.—M. Recordon, of Paris, communicates the fact to one of our French exchanges that two years ago he took out a patent for, and has since been manufacturing, illuminated watch-faces and clock dials on an entirely different principle from those produced by the use of chemicals. His device is this: A Geissler tube containing a gas which gives a brilliant light is placed on the dial; a battery about the size of a thimble is attached as an ornament to the watch chain, and a miniature induction coil is also hidden in the latter. When it becomes desirable to consult the watch in the dark, a spring is pressed, the current passes into the coil, then into the Geissler tube, and illuminates the dial. The portable battery used for this purpose is that of Trouve, which, in a small compass, has considerable strength. Reduced to the size of a thimble, it is still sufficiently strong in its action to last a year. M. Recordon also applies the same principle to the illumination of clock-faces.

A PHENOMENON causing much anxiety amongst the inhabitants of the shores of the Amazon is the continued rapid decrease of that generally colossal river. It appears that navigation above Manos has become an impossibility. The cause of the continued decrease of the quantity of water is entirely unknown at present, and it is most desirable that men of science should thoroughly investigate the matter.

Richardson's Improved Indicator.

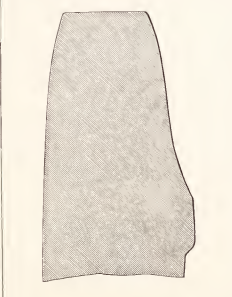
THE accompanying engraving illustrates an improvement in the Richards indicator, made by Mr. Richardson, works manager to Messrs. Elliott Brothers, Strand. The engraving almost explains itself. In order to reduce the momentum of the moving parts, Mr. Richard-



son does away with the ordinary parallel motion, and substitutes a slotted guide of stout brass, through which the pencil works as shown. The pin through which the copper pencil point passes carries a small steel roller, which is just a nice fit in the slotted guide, in which it works almost without sensible friction. We are disposed to regard this as a valuable improvement, reducing as it will the size of the instrument, and diminishing the weight of the levers to be put in motion by about one half.

A Durable Spur-Wheel.

We have received from Messrs. George and William Bertram, of St. Katherine's Works, Edinburgh, some interesting particulars of the durability of a mortise-wheel now working at the Kelvinvale Paper Mills, near Glasgow, belonging to Messrs. E. Collins & Sons. This spur-wheel was made and geared by Mr. George Bertram, of Sciennes, Edinburgh, and set to work in 1851, it having now been running 26 years day and night, and during the whole of that time not a cog having been touched. Lately the wheel began to get off pitch, or otherwise it might have gone on longer; under the circumstances, however, it was considered unwise to permit this.



The wheel, which is 14 ft. 0½ in. in diameter at pitch line and 10 in. wide on the face, is fixed on the crank-shaft of a beam engine, and has run at an average speed of 38 revolutions per minute, the speed during the latter half of the

period it has been at work being, however, 45 revolutions per minute. The wheel drives a machine-dressed pinion 4 ft. in diameter with 50 teeth; and the power developed by the engine is from 20 to 250 indicated horse-power. From a half-cog with which we have been favored by Messrs. Bertram we have prepared the annexed fac-simile of the present shape of the teeth, showing the amount of wear.

Taking the speed of the pitch line as 586 ft. per minute, and the mean horse-power transmitted as 84 (being the indicated power of the engine less engine friction), we get $\frac{33,000 \times 84}{586 \times 10} = 47.1$ as the average pressure on the teeth per inch of width. Taking the working days at 283 per year, thus allowing a large margin for stoppages and Sundays, and only 20 working hours per day, the cog we have received has travelled not less than 2,900,000 miles, or fully 118 times round the circumference of the globe. The beech from which these cogs were made was grown in Midlothian, and they were greased twice a week, tallow and lead ore being the lubricant used. The half-cog we have received shows very uniform wear throughout its width, the surface being very smooth and there being no signs of scoring. Altogether the performance of the wheel is of much interest.—*Engineering.*

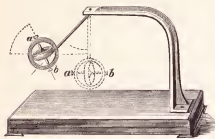
The Mechanic Poet of Belgium.

THE national poet is Antoine Clesse, who is by trade a gunsmith, and may be found any day in his shop, Rue de Havre, at Mons, selling breech-loaders and lead ore being the lubricant used. The half-cog we have received shows very uniform wear throughout its width, the surface being very smooth and there being no signs of scoring. Altogether the performance of the wheel is of much interest.—*Engineering.*

While making gun-barrels, however, he addicted himself to the reading of poetry, and one day he bought at an old book-stall a copy of Boileau's works, which at once fired his imagination. Boileau was poet of the cold, correct school, and his "Art Poétique" (which is but a free rendering of Horace's "Ars Poetica") is not the kind of work which might be expected to kindle latent genius into flame, but Clesse, having once tasted the inspiration of the French classic, he studied other poets; he spent all his spare time in reading, instead of going to the café, and the result was that, in 1830 the Society of Arts and Sciences of Hainault having offered a prize for a poem founded on some patriotic theme, Clesse wrote an ode entitled "Godefroy de Bouillon," and carried off the gold medal. He was twenty-three then, and this first success decided his vocation; but he was sensible enough not to abandon his trade to seek a precarious livelihood in literature, and for many years he continued to forge rhymes in the intervals of forging iron, hammer in hand, with a leathern apron on. In 1841 a small volume of his early poems was published. In 1843 he wrote an inaugural ode, which was delivered at the opening of the handsome new theatre in Mons; in 1845 and 1848 fresh editions of his songs appeared, and it was in the latter year that Béranger, writing to him from Passy, said with feeling admiration: "I consider that you have now attained to the foremost rank among song-writers." This was not excessive praise, for, though Clesse had not yet given the full measure of his powers, he had proved that he could handle his pen in many different styles and be turn by turn jovial, pathetic, and pointedly satirical. Joviality is, however, the dominant key in Clesse's songs, and since a comparison between his manner and Béranger's here suggests itself, one may say that the Belgian has in many respects the advantage over his French master. Béranger wrote some exquisite things, but he too often disgraced his pen by ribald coarseness and an intensity of party malice, for which he expressed contrition in his declining years. Clesse has never written a line which a child might not read.

Simple Scientific Experiments.

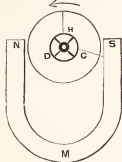
THE GYROSCOPIC PENDULUM of M. Gruey is illustrated in the accompanying engraving, as exhibited by him to the French Academy of Sciences and described in *Les Mondes*. A ring is suspended by a thread of india-rubber. Within the same a circular disk revolves freely with its axis ab . When at rest the apparatus is in the vertical position, as indicated by the engraving. If, while in this position, the thread be twisted up and again allowed to untwist,



after a rotary motion has been imparted to the disk T by striking it with the hand, the equilibrium is at once disturbed. As the thread twists and untwists alternately the pendulum assumes an inclined position and oscillates around a conical space with wide base, till the energy of the rotary motion of the disk T is exhausted and the latter is at rest.

This simple and easily constructed apparatus well illustrates the principles of bi-rotary or, as it is sometimes called, paradoxical motion, of which the common gyroscope is a familiar sample.

A CURIOUS THERMO-MAGNETIC MOTOR is the joint discovery or device of Professors Thompson and Hughes. The engraving and description of this simple affair are from the *Journal of the Franklin Institute*.



During investigations by the authors, concerning the increase in the coercive force of steel by changes of temperature, the following curious thermo-magnetic motor was devised:

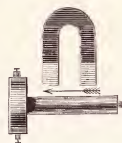
In the figure, a disk or ring of thin steel D is mounted on an axis, so as to be quite free to move. The edges of the wheel are placed opposite the poles H and S of a magnet. In this position the wheel of course becomes magnetized by induction.

If now any section of the wheel, as H , be sufficiently heated, the disk will move in the direction shown by the arrow. The cause of this motion is as follows: The section H when heated has its coercive force thereby increased, and being less powerfully magnetized by the induction of the pole S than the portion C immediately adjacent to it, the attraction exerted by the pole S on the latter portion is thereby sufficient to cause a movement of the disk in the direction shown by the arrow. If a constant source of heat be placed at H , a slow rotation in the direction shown is maintained.

To insure success, the disk must be sufficiently thin to prevent its acquiring a uniform temperature. If the source of heat be at the same time applied at diametrically opposite portions of the disk, as at H and D , adjacent to the poles, the same effect will be produced. Since the amount of heat expended in producing motion of the disk is so enormous when compared with the force developed, it will be readily understood that this motor is of no value as such, but must be regarded as an interesting example of the interconvertibility of force.

A CURIOUS TELEPHONIC PHENOMENON, says the *Telegraphic Journal*, of special interest just now from its possible bearing on the theory of

the source of sound in the Bell telephone, has just been observed by Mr. Stroh, the well-known mechanician. If a telephone, with the circuit of its coil left open, be held to the ear and a powerful magnet be moved gently up and down along the length of the magnet, as shown by the arrow, and at a distance of an



inch or two from it, a faint breathing sound will be heard; the recurring pulses of sound keeping time with the up and down motion of the magnet. The sound may be aptly compared to the steady breathing of a child, and there is a striking resemblance between it and the microphonic sounds of gases diffusing through a porous septum, as heard by Mr. Chandler Roberts. Professor Hughes is investigating the cause of this curious sound by help of the microphone.

INCREASE OF WEIGHT DURING COMBUSTION. The products of combustion always weigh more than either the substance burned or the supporter of combustion which combines with it. To show this increase of weight, the apparatus illustrated in the engraving may be used; or a slight change will enable the experiment to be performed with any ordinary balance. A piece of candle is attached to a cork having draft holes pierced in it. The attachment is



easily made by melting the lower end of the candle and sticking it to the dry cork. A piece of glass tube which the cork will fit, and of larger diameter than the candle, must be provided, and, by enlarging its upper part, drilling or otherwise, adapted to be supported by a wire from one end of a balance beam. A little wire gauze should be stuffed into the upper end of the tube as shown. The apparatus thus prepared should be put together before lighting the candle and brought to exact balance by weights in the pan opposite the tube. Now take out the cork with the candle attached, light the candle, and immediately replace it in the bottom of the tube; after a little the tube end of the balance will descend, showing increase of weight. The products of combustion are in this case carbonic acid (compound of carbon and oxygen) and water (compound of hydrogen and oxygen), which together weigh more than the wax or tallow consumed.

MELTING OF ICE BY PRESSURE.—It is a good season of the year for the performance of the following experiment, as ice may now be readily obtained by so many ways. Place a cake of ice on two supports—chairs will do. Pass over it a fine iron wire, and hang a heavy weight (a big stone will do) upon it, as shown. In a short time the wire will pass wholly through the ice, and fall, while the ice block

will remain in position without a mark to indicate the path of the wire. The ice melts in ad-



Edison's Electro-Motograph.

THE following is the substance of a description of the above invention, as given recently in one of the New York dailies. It is not very clear, but it perhaps gives a hint at the general principle of the invention.

A diaphragm of mica, four inches in diameter, is held in a suitable framework. A hand crank is made to rotate a small chalk cylinder (previously impregnated with the proper chemical solution), with a continuous forward motion directly outward from the face of the diaphragm. One end of a metal bar is fastened to the centre of the diaphragm, and the other end rests upon the chalk cylinder, being held down very firmly by a spring. The circuit is made from this metal bar, through the chalk cylinder to the base. As the cylinder is rotated either by hand or other power the friction between the metal bar and the chalk cylinder is very considerable, and the diaphragm is drawn or bowed outward toward the cylinder. This operation is purely mechanical and local. When the electric waves are transmitted from the distant station by the speaker (who uses Edison's carbon transmitter) over the wire to the receiver, each wave as it passes through the chalk cylinder effects more or less neutralization of the friction between the bar and the cylinder, according as the wave may be a strong or weak one. The resultant effect of each wave is the freeing of the diaphragm, permitting it to regain its normal position. Thus a series of electric waves, with the alternate space between, effects a vibration of the diaphragm in perfect accord with the voice of the speaker, the action being solely electrical and chemical. In this new telephone apparatus Edison dispenses entirely with the electro-magnet, heretofore used in all telephone receivers, substituting the electro-motograph principle. This, by its greater delicacy and power, is made to vibrate a very much larger diaphragm than is possible with the electro-magnet, thus giving greater volume of sound and obviating the necessity for holding the telephone to the ear. By it the voice of the speaker is transmitted to the distant station without the loss of volume. In fact, at times with very considerable increase, the telephone speaks louder than the person talking at the transmitting station. It also produces the highest musical notes with the same perfection as the lower ones, something that was found impossible in the old machine. These points of superiority over the electro-magnet are due to the fact that while in the electro-magnet the electric waves constitute the force which vibrates the diaphragm of the receiver, in the new machine they only control it, the force used being strictly local, either the power of hand or clockwork.

A NEW TEST-PAPER is said to have been invented by M. Lacour. It is prepared by adding to rhubarb double its weight of liquid ammonia, which produces a magnificent red purple. After a quarter of an hour the liquid is separated by filtering, and strips of filter-paper dipped in it are then dried. Under the influence of acids the paper becomes a lemon yellow, and with alkalis it regains its former color. It is asserted to be a very sensitive test.

A Real Telegraph.*

A NEW invention of a real practical character, not a mere "paulo post futurum" invention, like many we have heard of lately, has just been made by Mr. E. A. Cowper, the well-known mechanical engineer. It is a real telegraphic writing machine. The writer in London moves his pen, and simultaneously at Brighton another pen is moved, as though by a phantom hand, in precisely similar curves and motions. The writer writes in London, the ink marks in Brighton. We have seen this instrument at work, and its marvels are quite as startling as those of the telephone. The pen at the receiving end has all the appearance of being guided by a spirit hand. The apparatus is shortly to be made public before the Society of Telegraph Engineers. We give a fac-simile of the writing produced by this telegraphic writing machine.

How Japanese Bronzes are Made.

In a report to Sir Harry Parkes on the commerce of Hogo and Osaka for the year 1878, which has just been issued by the British Foreign Office, Consul Flowers says that from the beautiful and richly-chased articles which are turned out, one would expect to see large manufactories provided with modern appliances of every description, but in reality the work-shops are no better than ordinary blacksmiths' shops. The process is roughly as follows: "The moulds, which of course vary according to the shape of the vase or bowl it is desired to make, are made of wood, sometimes covered with straw. On this a coating of clay is placed; over this comes a layer of wax, which is moulded into the design required. Another thick coating of clay is then added, and the inner wooden mould being taken out, the orifice at each end is closed. Two holes are then made at one end, connecting with the layer of wax, so as to enable the wax, when melted, to run out, and through these the molten bronze enters, filling the interstices occupied by the wax. The subsequent process of casting is of the rudest kind. The earthen mould is placed in a small clay oven hollowed out in the floor of the workshop, the size of which depends upon that of the casting. The oven is then filled with charcoal and closed, with the exception of circular opening at the top, on which a chimney, a foot or so high, is built of wet clay. The oven is connected underground with a wooden bellows, protected from the sparks and heat from the furnace by a small earthen or stone wall a foot high, and which is worked by hands and feet. The first operation is to melt the wax, which runs out leaving the impression of the design stamped firmly in the surrounding layer of clay. This done the mould is taken out and allowed to cool. It is then put a second time into the furnace, as before, and the molten bronze is then poured into the mould through the holes by which the wax escaped. After the bronze has filled the mould the chimney is knocked off, the oven is supplied with fresh charcoal laid evenly round the mould, and a lid being put on the oven, furnished with small perforated holes, the bellows are set to work to heat the metal according to the size of the casting taken. This operation generally occupies a day. When the casting is taken out of the oven the earth outside and inside is scraped off

and reveals the vase or bowl, in a rough state. It is then put into the hands of rough workmen, boys being mostly employed in this part of the work, by whom it is polished and scraped with a knife until it presents a smooth surface. It then passes on to the carver, who fills in the details of the designs. When his work is done the vase or bowl is dipped into a boiling solution of vinegar, sedge, and sulphate of copper, in order to give it the proper color. A few finishing touches in the way of polish are added, and the article is finished and ready for sale."

Progress in Sciences and Arts.

ARTIFICIAL DIAMONDS.—The *Popular Science Monthly* states that among the papers of the late M. Gaunal was found a memoir purporting to have been some years ago presented to the French Academy, but which was not noticed by that institution. The document contained a description of the following process for the manufacture of diamonds: "Phosphorus is allowed to act upon liquid carbon disulphide (both as pure as possible). A decomposition of the liquid slowly ensues, the sulphur uniting with the phosphorus, and the carbon separating itself in the form of dodecahedral diamonds of the size of a millet seed. The purity of these crystals, it is stated, was proved, by the strictest tests, by M. Gaunal and others. The experiment was repeated many times by M. Gaunal, and always with the same results. The artificial diamonds had apparently the same hardness as the natural stone. The process is described to be very slow, as much as six months being required before crystals of the size above named made their appearance.

GAS VERSUS ELECTRICITY.—*Nature*, in discussing this subject, seems to think that gas properly burned may rival the electric light. It says: "An actor of the London gas companies has been trying to show what gas-lighting can be made, if only the public are willing to go to the necessary expense. On Friday last the Gas Light and Coke Company lit up part of Regent Street in much the same way that the Phoenix Company recently did the Waterloo Road. The result is described as admirable. By the use of Sugg's improved form of burner, a light framework, and the proper adjustment of suitable reflectors, a light was obtained very much brighter than that to which we have been so long accustomed. We believe if some enterprising company undertook to light one of our principal thoroughfares for some months at their own expense by this method, they would most likely be rewarded by a demand on one part of the public that the new form of light should be made general and permanent. Some comparative experiments which have been made at Westgate-on-Sea with the Jabluchoff candles have led the experimenters to the conclusion that this form of electric lighting is much more expensive than gas, and is surrounded with so many impossibilities that no amount of improvement is likely to fit it for adoption.

AN IMPROVED TRAMWAY, invented by H. P. Heuver, is stated to be at work on the premises of Messrs. Roebing, at Trenton, N. J. It differs from other tramways in having the load moved on a suspended track, instead of a road, posed of five-eighths inch diameter round steel rods, the pulling being done by a small wire rope. The power required is very small, a six horse-power engine transporting 100 tons of material per hour with ease. The arrangements for turning off at any angle, and returning, are very perfect, and are so arranged that it is almost impossible for any thing to become misplaced. Several of the tramways are to be built for use on sugar plantations, also to transport nitrate from the mountains about ninety miles back from the coast of Peru.

A SUBSTITUTE FOR LEATHER BELTING is another innovation manufactured by a German firm. We extract a description of the article from the *Gesunde Zeitung*. These driving belts are of the best crucible steel wire, in transverse network of one to two wires, in any desirable length and width. The two ends of the belt are joined like the middle, so that there is no beginning and no ending, the belt forming an endless band. These belts are not to be confounded with flat wire ropes, which, in consequence of the wires running parallel, longitudinally, are stiff and immovable. All the wires run parallel only across the width in such a manner that one wire catches into the other like a spiral, a continuous densely-woven chain

being thus produced, the movability of which is so great as to enable it to go round the smallest pulley. The straps are also made with leather or elastic lining, or bordered with leather, elastic, hemp, hair-tape, or any other material, also its interstices filled with gutta-percha, to prevent their stretching. When large and broad belts are employed the lining of leather or other material may be omitted. The journal quoted makes very positive assertions of the advantages of these belts, claiming that they are in every way superior to all flexible transmitters of motion heretofore employed.

TELEGRAPHY WITHOUT WIRES.—The *Kansas City Review of Science and Industry* in its last number gives the following facts relating to Prof. Loomis and his experiments: "He claims, it will be remembered, that he can telegraph from one part of the country or world to another without the use of connecting wires, except those that he needs to reach up to a certain altitude, where his experiments have shown that there is at all times a natural current of electricity. His experiments are conducted from the high hills of the mountains, which he has telegraphed as far as eleven miles by having kites raised at each end of that distance, flying them with a fine copper wire instead of string. The instant they reached the same exact altitude, or got into the same current, telegraphic communication, by aid of an instrument similar to the Morse instrument, could be carried on as perfectly as if the two kites were connected by wires. The lowering of one kite would, however, break off the communication immediately. This demonstrated to the professor that his wires should be stationary to keep constant communication. Accordingly he built a kind of telegraphic tower at the tops of two hills about twenty miles distant, and from them put up a steel rod by which a certain aerial current of electricity was reached. For months at a time he has been able to telegraph from one tower to another. A heavy storm disarranges the connection, but it can be readily restored after the storm has passed. In this respect, however, it is not more unreliable than the ordinary telegraph connections by wire, which are broken up by many storms. A letter was received from him, by the telegraph, some days since, by Mr. D. C. Forney, of the *Sunday Chronicle*, in which he said that recently he had met with the most remarkable success in his experiments, and had demonstrated by repeated tests that the telephone could be used as easily as the Morse instrument, and that lately he had done all his talking to his assistant, twenty miles away from him, by the telegraph, the connection being aerial only. He added that he had been in correspondence with Edison for a long time, and that he had received many valuable hints from him, and that Edison had been fully convinced for a long time that aerial telegraphy was practicable, and had so expressed himself to him frequently. Edison also thinks that his aerophone can be worked by the same means. It will be readily seen that if telegraphing can be carried on without wires, according to the idea of Prof. Loomis, the expense of the same will be reduced to almost nothing in comparison to the cost of building and keeping telegraph lines in order under the present system.

"SCIENCE," says Dr. Holmes, "is a good piece of furniture for a man to have in an upper chamber, provided he has common-sense on the ground floor."

AN ingenious Meriden mechanic has made a perfect steam-engine, the works of silver and gold, which only weighs fifteen grains, and three drops of water, when heated into steam, will drive it twenty minutes.

An Important Invention in Iron Manufacture.

A VERY important invention, the Manchester *Comics* says, has just been patented in Great Britain, Belgium, the German Empire, France, and the United States of America. The growth and development of the steel trade on the west coast has practically resulted in the stoppage of many furnaces and a large number of iron-rolls in the Cleveland district, and scientists and metallurgists have been experimenting for some months with a view as to the means, if any, by which Cleveland iron can be dephosphorized. The inventor claimed that he could do this by simple and inexpensive means, and that he could place a high-class steel in the market at a much less cost than by

**Nature*, Feb. 6th, 1879.

the Bessemer process. The inventor left his widow and son, Mr. J. Perry Downing, solicitor, of Götteshead, in possession of the secret of manufacture before his death, and they have since disposed of a portion of their interest to certain firms. The invention has for its object the manufacture of iron of superior classes from ores of any description or from pig-iron, and purifying them from matters of an objectionable nature by a single operation of smelting; also for the manufacture of steel from either poor pig-iron, or from pig-iron, even if such iron ore or pig-iron contains chemical combinations of a detrimental nature which at present are not eliminated by one single furnace operation. A suitable furnace or cupola is employed, capable of resisting great heat. Common iron, contaminated with phosphorus, such as Cleveland iron, to the extent of, say, for example, one ton, is placed into the cupola of No. 3 quality. To this add one hundred-weight of good iron, such as that made from charcoal; 25 pounds to 65 pounds of scoria, or tap cinder, obtained from puddling or mill furnaces, and about 100 pounds of scrap iron. These are melted together for about half an hour, and the furnace run at the heat at which cast-steel melts. When the iron is in a liquid state the heat should be continued for two hours. The metal is then drawn off, when it will be found to be perfectly refined iron, which, of course, can be improved in quality by the addition of larger quantities of the good iron. For ordinary purposes the above quantities will be found sufficient. The chief merit of the discovery, however, is the production of good steel from poor pig-iron or ores, by refining, in the first place, the iron, and then by adding nitrogenous and other compounds, converting the same by one smelting operation into genuine steel ingots, having such properties as to enable them to be manufactured into tools, bars, plates, rails, &c. In a malleable furnace, well lined, one ton of pig-iron, 25 to 65 pounds of scoria, and 100 pounds of good scrap iron are placed, and when these are melted the furnace is run at a heat at which cast-steel melts. This is continued for 30 or 40 minutes, when it will be found the scoria has taken up such impurities as have not been volatilized, and this will be found floating on the surface, and must be tapped off; 25 to 65 pounds of good iron is then added, and the whole lightly stirred. Three ounces of black oxide of manganese is then introduced, and this is immediately followed by 4 pound to 31 pounds of chloride of ammonia. The furnace is run again for about 30 minutes, when 100 pounds of speisgeisen is introduced, and the whole lightly stirred. Care must be taken not to puddle or boil the contents of the furnace, which, when at a great heat, are run off into ingots. The chemical combinations in this process act and react upon each other in such a way as to eliminate detrimental bodies by a species of synthesis, and then, by the introduction of nitrogen into the iron, it is converted into steel. The invention is of the greatest importance to the Cleveland district, and it will doubtless, on the return of a brisk trade, be the means of giving it a new lease of life.

For some time past the well-founded fear of trichina has led to a microscopic examination of much of the meat, especially pork, sold in Berlin.

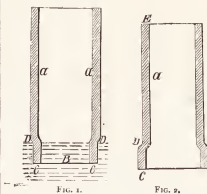
Refitting Wrought by Fire and Water.

BY JOSHUA ROSE, M.E.

WORK of wrought iron, copper, and to a certain extent of steel also, may often be refitted by the agencies of fire and water, the principles involved in the process being as follows:

Suppose in Fig. 1 *a* represents a piece of wrought-iron tube that has been heated to a bright red and immersed in cold water *c* from the end *B* to *D*, until that end is cold. The part submerged and cold will be contracted to its normal diameter and have regained its normal strength, while the part above the water, remaining red-hot, will be expanded and weak. There will be, then, a narrow section of the tube, joining the heated and expanded part to the cooled and contracted part, and its form will be conical, as shown at *DD*. Now, suppose the tube to be slowly lowered in the water, the cold metal below will compress the heated metal immediately above, the water, also, the cone section *D* being carried up into the metal before it has had time to cool; and the tube re-

moved from the water when cold will be as shown in Fig. 2, from *c* to *D*, representing the part first immersed and cooled. To complete the operation the tube must be heated again from the end *c* to a short distance past *D*, and then immersed from *E* nearly to *D*, and



held still until the submerged part is cold, when the tube must be slowly lowered to compress the end *C**D*, making the tube parallel, but smaller in diameter and in bore, while leaving it of its original length, but thickening its wall.

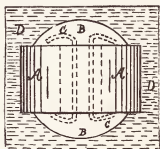


FIG. 3.

This process may, in many cases, be artificially assisted. Suppose, for example, a washer is too large in its bore; it should have its hole and part of its radial faces filled with fire-clay, as shown in Fig. 3, in which *A* is the washer and *B* the clay, *c* being pieces of wire to hold the fire-clay and prevent its falling

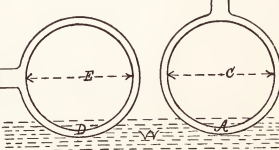


FIG. 4.

off. The washer should be heated to a clear red and plunged in the water *D*, which will cool and shrink the exterior and exposed metal in advance of the interior, which will compress to accommodate the contraction of the outer metal, hence the hole will be closed tight. This operation may be repeated until the hole is entirely closed.

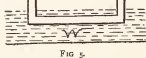


FIG. 5.

Another method of closing such a piece as an eye of large diameter compared to its section is shown in Fig. 4: first dipping the heated eye at *A* and holding it there till cold and then

slowly lowering it into the water, which would close the diameter across *B*, and, after reheating, dipping at *D* till cold, and then slowly immersing, which would close the eye across *E*. To shrink a square ring, the whole ring would require to be heated and a side of the square dipped just below the surface of the water and there held still, as shown in Fig. 5, until quite cold, and then immersed slowly for about an inch, the operation being performed with a separate heating for each side. Connecting-rod straps, which are made of a large variety of work may be refitted by this process, but in each case the outside diameter will be reduced.

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The following letter is from one of the recipients of the prize offered for the solution of the wheel problem, propounded in No. 23, current volume:

TO THE EDITOR OF THE SCIENTIFIC NEWS: I take pleasure in expressing my heartfelt thanks for your proposal to me. The SCIENTIFIC NEWS will be doubly precious to me as a choice neat paper, and by getting it in the way I have, as a present from you. I was very much pleased at seeing my name with the successful one.

I take especial pleasure in reading Shop and House Hints, in which I find many good and useful receipts. If you think it worth space in your paper, you may state that my experience is that a good and cheap black walnut stain is made of lye and raw amber, in proportions to produce the color. Applied hot, the stain is deeper. Apply with an old brush. A good mahogany stain is made of extract of logwood and lye. For light and soft wood, a nicer stain is obtained by using alcohol in place of lye. For cherry wood, simply apply lime-water, strong and hot. Dry, rub clean, and oil to bare varnishings. Wishing you success, I remain yours, &c.

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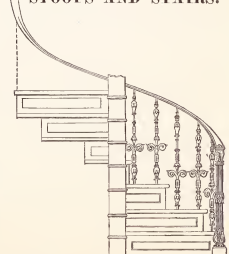
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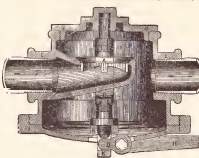
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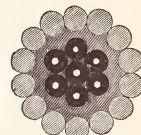
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